

Broadband Array in Taiwan for Seismology (BATS): The current status and future development

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Summary

The Broadband Array in Taiwan for Seismology (BATS), which was composed of 14 permanent stations spanning a 400 km x 400 km area in the Taiwan region, has been established by the Institute of Earth Sciences (IES), Academia Sinica, Taiwan since 1995. In the past 7 years, the BATS has continuously collected high-resolution waveform data generated from local and distant earthquakes. After the 1999 Chi-Chi, Taiwan earthquake ($M_w=7.6$), the Central Weather Bureau (CWB) decided to significantly upgrade its earthquake monitoring capability by installing another 26 broadband stations in the Taiwan region. Up to the end of 2002, the BATS operates **38** stations, including the newly CWB-installed ones. Excluding TATO (which is a GSN station), the total number of BATS stations will reach **45** or more by the end of 2003 (**Fig. 1**). Almost all the real-time data streams are continuously transmitted back to both IES and CWB using frame-relay technique and routinely archived in SEED format (**Fig. 2**). We then utilize the USGS Earthworm system for data exchange, automatic earthquake location, and waveform viewing (**Fig. 3**). In addition to regularly forwarding waveform data to FDSN, we have also adopted a networked data distribution system (NINJA, *Takeuchi et al., 2002*) that is developed by the Ocean Hemisphere Project (OHP), Earthquake Research Institute, Tokyo University, Japan to provide on-line access to BATS waveforms. Users can simultaneously extract both BATS and OHP broadband seismic data through a NINJA program or alternatively visit either the website of Data Management Center of IES (DMC-IES) or OHPDMC to send their data request. In practice, the application of NINJA has established a virtual seismic data center in the Western Pacific region (**Fig. 4**). The DMC-IES is also responsible for obtaining the Centroid Moment Tensor (CMT) solutions for felt earthquakes that occurred in the Taiwan region, by inverting the recorded BATS waveforms. Interested readers can subscribe to quick BATS CMT reports from DMC-IES at <http://bats.earth.sinica.edu.tw>. Since the real-time data processing technology is getting more stable and flexible, data exchange with FDSN members in a real-time manner is welcome and will be implemented in the near future.



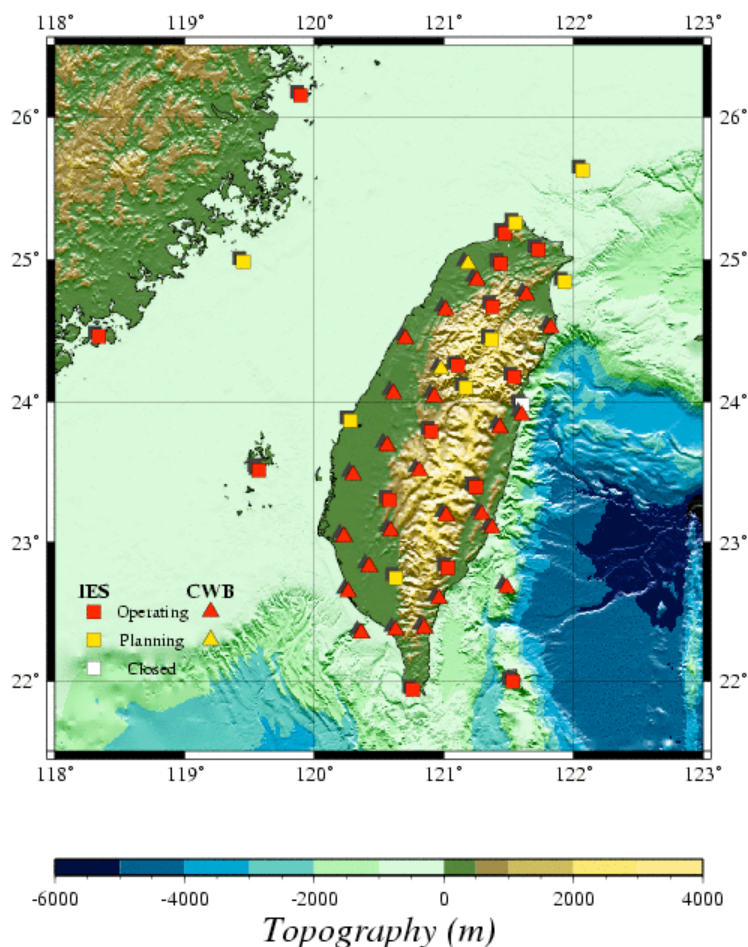


Figure 1. The BATS stations deployed by IES (square symbols) and CWB (triangle symbols). IES stations are mainly equipped with STS-2/ STS-1 sensors, whereas the CWB stations are equipped with *Güralp* CMG-3ESP or 40TD. Yellow symbols indicate stations under construction. Including one GSN station (TATO), the total number of broadband stations installed in Taiwan region can reach 45 by the end of 2003. (see <http://bats.earth.sinica.edu.tw/Station/> for more information)

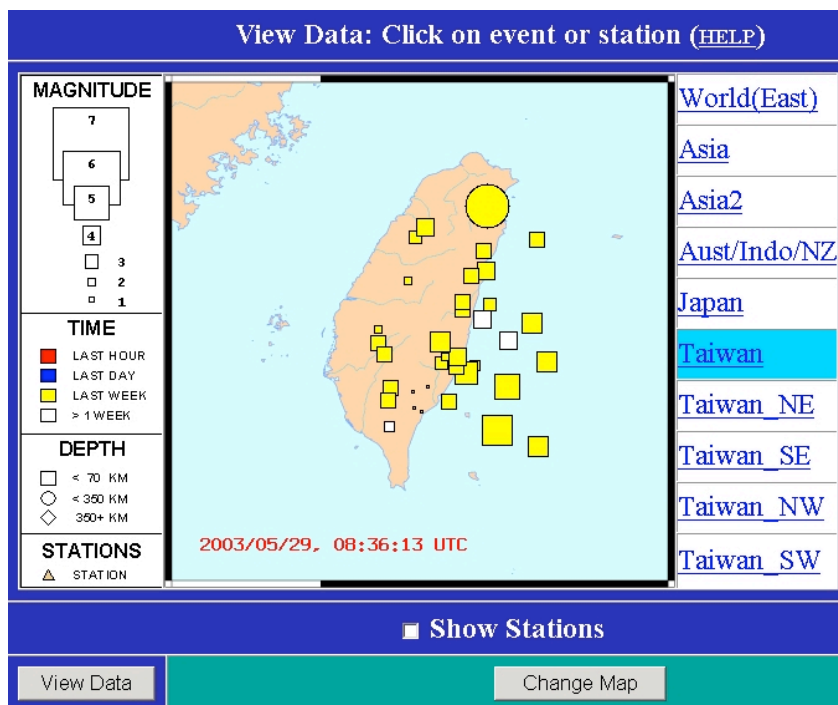


Figure 2. The real-time BATS data streams are processed via Earthworm system for automatic location, data archiving, and waveform viewing.

Archived miniSEED volume

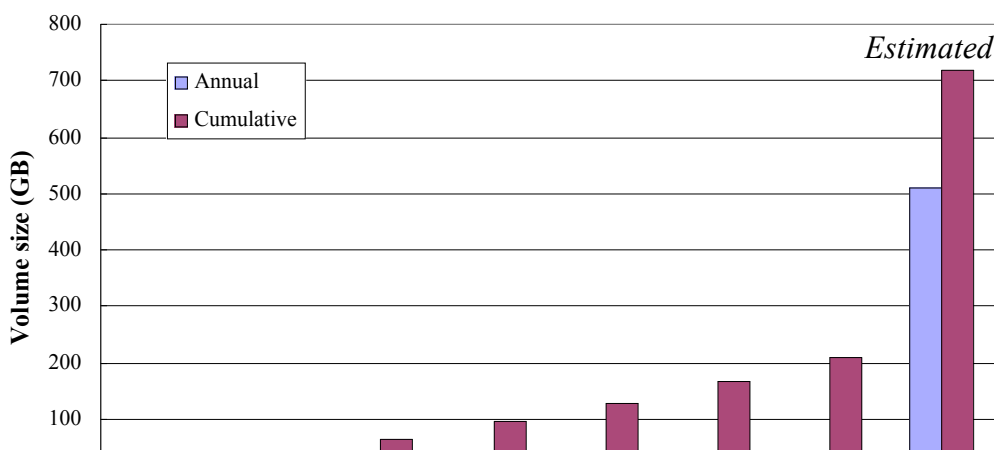


Figure 3. The BATS miniSEED volume archived in DMC-IES in the past 7 years. Before 2003, the BATS produced about 350GB miniSEED volume per year. Due to the increase of broadband station, the amount of BATS data could reach a scale of 510 GB per year since 2003.

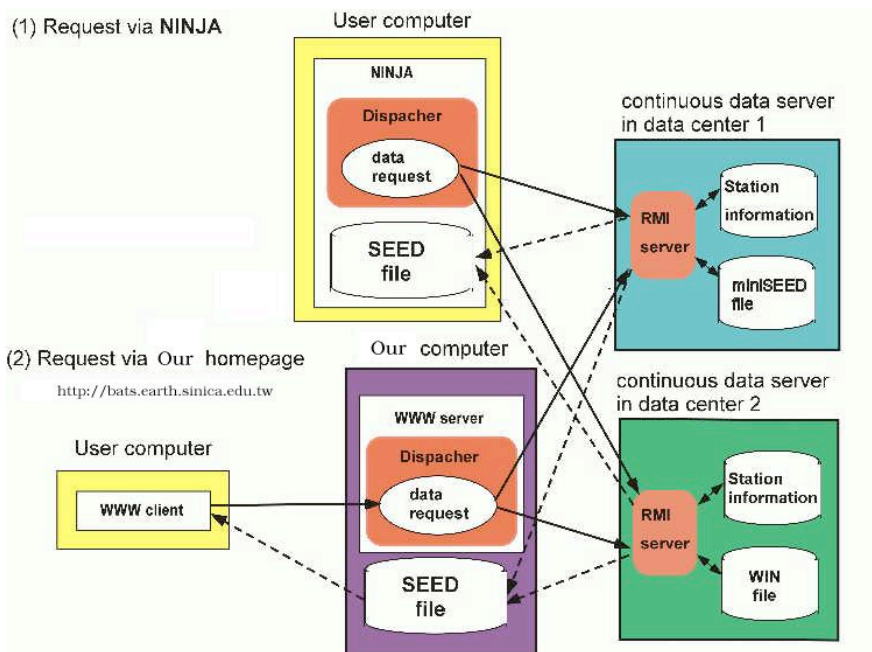


Figure 4. We adopt the on-line interface developed by OHPDMC, ERI, Tokyo University, Japan to distribute BATS waveform data. Users can collect both OHP and BATS waveform data via this distribution system without knowing where the data are exactly archived. [Takeuchi et al., Application of Distributed Object Technology to Seismic Waveform Data Distribution, *Seism. Res. Lett.*, 73, 166-172, 2002]